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NATIONAL DAM SAFETY PROGRAM. STERLING LAKE DAM (NJ 00434), DELA--ETC(U)
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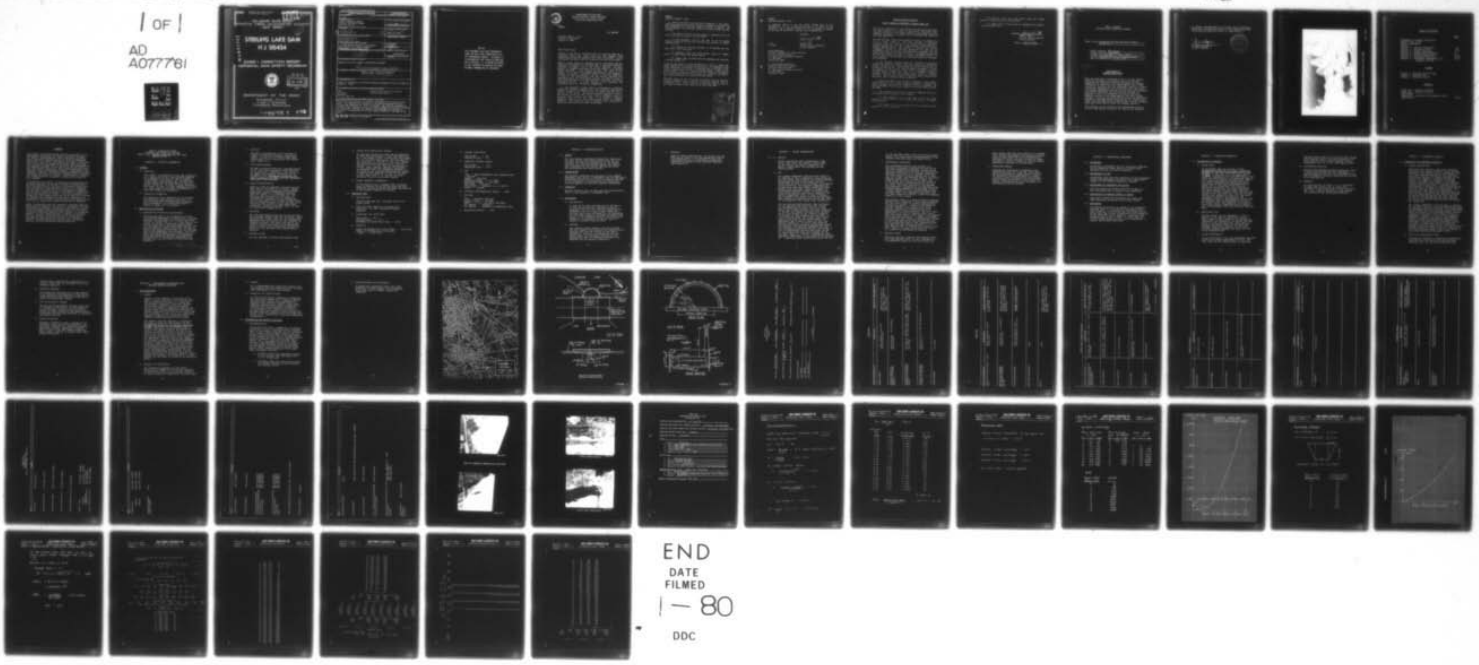

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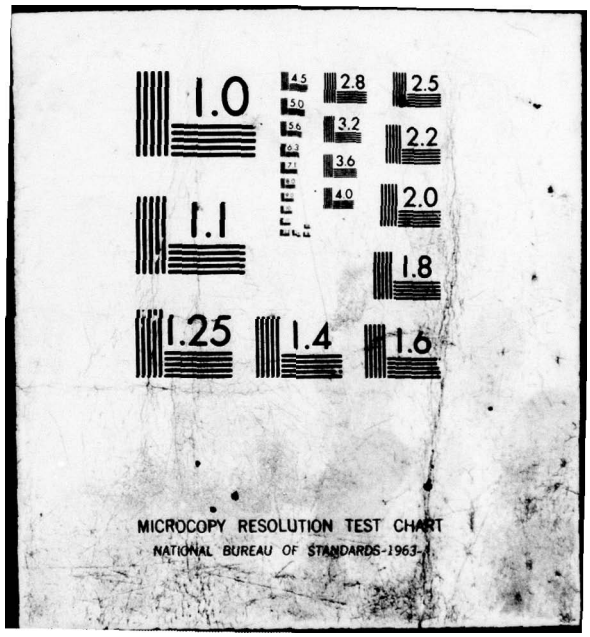
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LEVEL II

DELAWARE RIVER BASIN
MANTUA CREEK, GLOUCESTER COUNTY
NEW JERSEY

STERLING LAKE DAM
NJ 00434

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

August 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Spillways
Embankments
Vis ual inspection
National Dam Inspection Act Report
Sterling Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT. CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA. PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

27 NOV 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Sterling Lake Dam in Gloucester County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Sterling Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since seven percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition relative to seepage. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within one year from the date of approval of this report:

(1) The embankment areas at the ends of all the bridge wingwalls should be regraded and protected with concrete or asphalt slope protection.

(2) Inspect the submerged portions of the spillway wall and repair the 2' x 2' sluice gate.

(3) Construct curbs and catch basins along the roadway gutters to better control the surface runoff.

(4) Remove trees and brush from the embankment and establish a suitable ground cover.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Florio of the First District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

James G. Ton

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

STERLING LAKE DAM (NJ00434)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 13 July 1979 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Sterling Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since seven percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition relative to seepage. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within one year from the date of approval of this report:

(1) The embankment areas at the ends of all the bridge wingwalls should be regraded and protected with concrete or asphalt slope protection.

(2) Inspect the submerged portions of the spillway wall and repair the 2' x 2' sluice gate.

(3) Construct curbs and catch basins along the roadway gutters to better control the surface runoff.

(4) Remove trees and brush from the embankment and establish a suitable ground cover.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 Nov 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Sterling Lake Dam Fed ID# NJ 00434
NJ ID# 72

State Located New Jersey
County Located Gloucester
Coordinates Lat 3944.1 - Long. 7506.8
Stream Duffield Run Trib. of Mantua Creek
Date of Inspection 13 July 1979

[Cont'd from p. 1]

ASSESSMENT OF GENERAL CONDITIONS

Sterling Lake Dam is assessed to be in a fair overall condition although the spillway should be further inspected and additional hydrologic/hydraulic studies undertaken to ascertain what improvements can be made in view of the fact that the discharge culvert is almost completely submerged by the downstream lake. The very low roadway embankment portion of the dam is of secondary structural importance and the spillway culvert is believed to be in an adequate structural condition. Remedial actions to be undertaken in the near future include 1) protect the earth slopes along the downstream wingwalls with additional slope paving, 2) inspect and repair the spillway wall and sluice gate and 3) construct curbs and catch basins along the roadway gutters.

The capacity of the spillway will accommodate only 6% of the ½ PMF design flood but the dam is not assessed

as UNSAFE, NON-EMERGENCY as collapse from overtopping could not increase the hazard to life downstream from the erstwhile condition prior to overtopping.

F. Keith Jolls P.E.
Project Manager.

OVERVIEW OF STERLING LAKE DAM

MAY, 1979

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FIGURES

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: STERLING LAKE DAM FED #NJ 00434
AND NJ ID #72

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of Sterling Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Sterling Lake Dam is an ill-defined 150 foot long highway embankment structure with a bridged spillway. The spillway is a concrete arch weir 22 feet in length with a 2' x 2' wood gate in the center of the arch. Gloucester County Bridge #5-J-14 spans the 16 foot discharge opening. The two-lane asphalt Pitman-Downer Road (30 feet in width) runs along the dam crest. At the upstream face of the embankment are situated 3 foot high dikes with stone masonry walls keyed into the earth and supporting remnants of a boardwalk. The slopes of the downstream embankment vary between 1H:1V at the outlet to 3H:1V near the abutments. [Cont'd on p. X (five pages back)]

b. Location

The dam is located west of the Borough of Pitman in Washington Township, Gloucester County. It lies on the Pitman-Downer Road, ¼ mile east of the intersection with Delsea Drive (Route 47).

c. Size Classification

The dam at Sterling Lake has a maximum height of 14.5 feet and a maximum storage capacity of 98 acre-feet. Accordingly, this dam is in the small size category as defined by the criteria in the Recommended Guidelines for Safety Inspection of Dams (storage impoundment less than 1,000 acre-feet).

d. Hazard Classification

Based on Corps of Engineers criteria and the fact that in the event of a failure, damage could occur to the downstream dam and power substation located on Wadsworth (Kressey) Lake (NJ 00433). It is recorded that when Sterling Lake Dam failed in the past, it triggered the collapse of this downstream dam. Failure could also endanger Delsea Drive, a major thorofare which is only 250 feet below the latter dam. Based on these downstream conditions, roughly 1,000 feet away, the dam is classified as high hazard.

e. Ownership

The lake and possibly portions of the spillway are reputedly owned by Mr. Ray Contarino, Chapel Heights Road, Pitman. However, the roadway/dam embankment and the culvert are the property of Gloucester County. The exact position of the roadway right-of-way could not be determined, hence it could not be ascertained whether any portion of the spillway lies outside public property.

f. Purpose of Dam

The dam impounds a private recreational lake.

g. Design and Construction History

The spillway at Sterling Lake Dam was designed in 1925 and constructed in 1926. The design was by H. Lee Fisher & Sons, of Vineland, New Jersey for the Sterling Farm Agency, Inc. The name of the contractor is unknown. It was built against the County culvert designed by Mr. William C. Cattell, P.E. in 1922. This was constructed by the E.P. Henry Company, General Contractors. In September 1940, the embankment adjacent to the south of the spillway was washed out during a flood and was repaired in 1941 by the owner at that time, a Mr. J. T. Wilson. No other pertinent historic facts were located.

h. Normal Operating Procedures

At the present time it appears that no maintenance is carried out on the spillway but that Gloucester County performs continuous maintenance on the roadway elements of the dam.

1.3 PERTINENT DATA

a. Drainage Area

Sterling Lake Dam has a drainage area of 3.1 square miles.

b. Total spillway capacity at maximum pool elevation - 343 cfs (limited by culvert capacity)

c. Elevations (ft. above MSL)

Top of dam - 78.0
Spillway crest - 75.0
Streambed at centerline of dam - 66.5±

d. Reservoir

Length of maximum pool (top of dam) - 3,200 feet
Length of recreation pool (spillway crest) - 2,200 feet

e. Storage (acre-feet)

Top of dam - 98
Recreation pool - 60

f. Reservoir Surface (acres)

Top of dam - 17.0
Recreation pool - 8.7

g. Dam

Type - Earth embankment with concrete arch spillway
Length - 150± feet
Hydraulic height - 11.5 feet
Structural height - 14.5 feet
Top width - 50± feet
Side slopes - variable (1:1 to 3H:1V)
Zoning - unknown

h. Diversion and Regulating Tunnel - none

i. Spillway

Type - concrete arch weir
Length of weir - 22 feet
Gates - 2' x 2' low level sluiceway
U/S Channel - reservoir
D/S Channel - reservoir of Wadsworth Lake

j. Regulating Outlets - none

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The only design information located for review was one sheet of the 1925 construction plans for the spillway. The work was designed by H. Lee Fisher and Sons for the Sterling Farm Agency. No details were available for the County road culvert which was constructed four years earlier.

2.2 CONSTRUCTION

The spillway structure and portions of the roadway embankment were built in accordance with the designer's specifications and monthly progress reports were sub- to the Department of Construction and Development. The work appears to have been properly supervised.

2.3 OPERATION

Records indicate that the dam operated satisfactorily until it was breached in September 1940.

2.4 EVALUATION

a. Availability

In view of the size and position of the dam it is felt that sufficient engineering data is available. The 1925 test borings indicated the presence of 10 to 12 feet of marl under the spillway and during construction, the excavation for the timber sheeting cofferdam revealed sandy gravel in the foundation strata. The underlying formation is Kirkwood sand and the depth to bedrock is greater than 100 feet.

b. Adequacy

The original plans indicate that the spillway and arch culvert was carefully and conservatively designed and from the results of the field inspection, are built in accordance with the design plans. The available engineering and geotechnical data is therefore believed to be adequate for the subject inspection.

c. Validity

Based on field observations, the validity of the 1925 design plans is not challenged but further investigations will be required to assess the structural condition of the spillway crestwall (see Section 6).

SECTION 3 - VISUAL OBSERVATIONS

3.1 a. General

Visual inspections were conducted on 9 May and 13 July 1979. The reservoir water level at the time of the latter inspection was about 2 inches above the spillway and was flowing freely.

b. Dam

The roadway embankment portions were found to be substantial and in moderately good condition. The lake water level appears to be quite constant during most periods as the banks are well stabilized and show little evidence of sloughing at the waterline. The variable sideslopes are grassed over and have several good-sized trees placed along each side. There is evidence of considerable pavement runoff in certain locations which have cut out erosion channels. The upstream embankment slope is very irregular and it appears the lake has silted up considerably against the upstream face of the dam. There is no evidence of any riprap slope protection.

The low berm and stone masonry wall installed on the upstream face after the 1940 failure are overgrown and partially buried in some areas. Some asphalt gutters have been installed to control the roadway drainage which collects on all four corners of the culvert wingwalls. The culvert is positioned at the low point in a sag vertical curve. The lowest point occurs just to the right of the culvert where the embankment has a width of about 50 feet. The asphalt pavement is in fairly good condition but there is little apparent maintenance beyond the shoulder line and the embankment has lost all vestiges of engineered slopes. The height of fill is exceedingly low and the length of dam is conjectural and could vary between 100 to 150 feet. There is a narrow, dilapidated timber boardwalk immediately to the right of the spillway and a chainlink fence constructed across the top

of the spillway about 5 feet off of the bridge fascia. The fence could be approximately on the property line adjoining the County R.O.W.

c. Appurtenant Structures

The reinforced concrete arch bridge is in excellent structural condition in view of its age. The wingwalls and parapets display minor cracking and spalled areas but the structurally important zones are in an integral condition. The semi-circular culvert opening has a clear span of 16 feet. The headroom above a reinforced concrete paved invert is about 7 feet. The paved invert which forms the culvert floor is 6" thick and was installed when the spillway was built. The lower portions of the culvert are permanently inundated by the backwater from Wadsworth Lake immediately downstream, leaving a clear headroom of only two feet beneath the intrados crown. This backwater condition from the lower reservoir severely limits the hydraulic capacity of this outlet.

The spillway inlet is a semi-circular reinforced concrete wall connected to the bridge wingwalls. The top of the crest is severely spalled and covered with debris. A notch in the center of the wall appears to be patched with stone masonry, bringing the overall crest up to approximately a level elevation. The two 7 foot sidewalls on top of the circular arch, which were originally about 3 feet higher, were removed after the 1940 breaching, in order to increase the effective weir length. A considerable volume of water was welling up from beneath the wall on the downstream side at both inspections and this may have been passing through a 2' x 2' gate opening that is located at the base of the wall. There is no stem to the gate nor could its location be determined by probing.

d. Reservoir Area

Sterling Lake has a regular well-defined shoreline that extends about 0.4 mile upstream to its headwaters which are 0.85 mile below the

upper Kandle Lake dam. The reservoir is bounded with suburban development and has gentle banks, which in many areas are well protected with residential lawns. The lake is clear of debris and there is little evidence of silting except immediately adjacent to the dam face.

e. Downstream Channel

Duffield Run terminates in Wadsworth Lake immediately below the study dam. This lower dam is classified as a high hazard structure as immediately downstream there is a power sub-station and a hydraulically sub-standard culvert under Delsea Drive. Below that, the channel of Mantua Creek flows northward in a well-defined natural channel.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not physically observed by the inspection team. There is no day-to-day operation of the low level sluicegate.

4.2 MAINTENANCE OF DAM

Discussions were held with personnel of the Gloucester County Road Department who handle the regular maintenance of the roadway elements of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facility consists of the 2 x 2 foot sluicegate and it appears to be abandoned.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

None exists except for monitoring by County and local Municipal personnel during heavy storms.

4.5 EVALUATION

The present operations are deemed to be inadequate although there is no record of overtopping since 1940. However, it was noted that the failure of the Kandle Lake dam in 1940 contributed to the breaching of the study dam (which together, caused the Lake Wadsworth dam to fail). There is little that can be done operationally at this site to safeguard or improve operational efficiency.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria in the Recommended Guidelines for Safety Inspection of Dams, it has been determined that the dam is small in size and is in the high hazard category. Accordingly the spillway design flood (SDF) was determined by the inspection team to be one half the probable maximum flood (PMF). The inflow hydrograph was calculated using precipitation data from Hydrometeorological Report #33. In accordance with Corps of Engineers directives, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the ½ PMF was 5,630 cfs and when routed, this reduced to 5,483 cfs. The spillway capacity before overtopping of the embankment occurs is approximately 343 cfs and is therefore able to accommodate only 6% of the design flood. This capacity is limited by the almost totally submerged culvert opening and is considerably less than the flow over the weir.

b. Experience Data

Records reveal that on September 1, 1940 a section of the dam was washed out during a heavy storm. A major cause of the failure was reportedly the collapse of the Kandle Lake dam which is 6,500 feet upstream. There were no records available concerning the dam's performance since then. However, the original spillway capacity appears very small in view of the drainage area.

c. Visual Observations

It was noted that if the Lake Wadsworth reservoir level were lowered approximately 5 feet, the flow over the weir would govern the spillway

capacity rather than the restricted flow through the discharge culvert and would increase it to about 350 cfs. This increase however, would accommodate only 7% of the ½ PMF design flood.

d. Overtopping Potential

Based on the appended hydraulic analysis, there is considerable potential for overtopping. However, when the dam was last recorded to have been overtopped, the major cause was the failure of an upstream dam.

e. Drawdown

By utilizing the low-level 2' x 2' sluicegate, it would take about 1 day to lower the reservoir to the normal pool of Lake Wadsworth (El. 71.0). Further dewatering would require the lowering of the downstream reservoir.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based upon the existing conditions inspected and the single source of design plans, the dam embankment and roadway culvert are deemed to be in a fair condition except for the continual maintenance problem of roadway drainage at the ends of the wingwalls. Although no serious hazard is foreseen, a collapse of the semi-circular spillway could choke up the submerged culvert opening and create a hydraulic block which would be difficult to clear during periods of heavy flow. Although the design plans indicate the spillway wall is of substantial construction, the inspection team was concerned with the large amount of flow bubbling up from an unknown opening beneath the wall. The top of the weir is chipped and has been repaired but only a few feet of the rear face is visible for inspection.

The roadway embankment is quite wide in relation to its height and as a water-impounding structure, has adequate stability. Further, the timber sheet piling around the spillway andd culvert retaining walls contribute to an increased length of flow network in the rather short length of higher embankment. However, in view of the inadequate hydraulic capacity, overtopping could cause a wash-out of the downstream road shoulders and sideslopes along the culvert wingwalls, albeit the crest is paved with asphaltic concrete. Because of the sag curve in the road profile, the overflow would be concentrated in a single area and could possibly cause a breaching, similar to that which previously occurred in 1940.

b. Design and Construction Data

Although no hydraulic or structural computations were located, a review of the original plans indicates that the concrete intake and arch

culvert were conservatively designed and in spite of their age, are believed to be in an integral condition.

c. Operating Records

No records are available but the dam appears to be operating satisfactorily. There are no known instances since 1940 where overtopping caused any appreciable damage.

d. Post Construction Changes

The only post-construction changes since 1926 in evidence is the removal of the sidewalls on the spillway. Further, there has been a variety of slope protection and paved ditches installed along the road shoulders to channelize the surface run-off.

e. Seismic Stability

The dam is located in Zone 1 and due to its embankment width and spillway geometry, has negligible vulnerability regarding potential earthquake loadings. Experience indicates dams in Zone 1 will have adequate stability under dynamic loadings if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, the Sterling Lake Dam is classified as being in a sound and satisfactory structural condition although the spillway overflow weir and discharge culvert are grossly incapable of passing the design flood. The dam embankment was built of unknown composition but due to its broad width and low height, is felt to be of a sufficient impervious condition to withstand normal hydraulic heads anticipated as this site.

The present spillway capacity is inadequate and does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, being able to accommodate only 6% of the ½ PMF design flood as calculated by Corps of Engineers criteria. The SDF is calculated to overtop the dam by slightly more than 8 feet at the low point along the roadway and such an overtopping could easily breach the embankment. The spillway is not judged to be seriously inadequate, UNSAFE NON-EMERGENCY as failure from overtopping would not significantly increase the hazard to loss of life downstream from that which would exist prior to overtopping failure. The downstream flood plain is essentially uninhabitedly and the larger Lake Wadsworth could absorb a considerably portion of the overflow. Further, during periods of flooding, the differential in head between the two lakes is viewed to be relatively modest.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam. However, no recent surveys or inspections have been made.

c. Urgency

It is recommended that additional studies and the remedial measures enumerated below be taken under advisement in the near future.

d. Necessity for Further Study

In view of the serious inability to discharge any anticipated design flow, further hydraulic and hydrologic studies are recommended to ascertain what feasible methods (other than complete reconstruction) might be employed to alleviate the very substandard conditions. At the present time, lowering the level of the Lake Sterling reservoir would provide only minimum additional retention during floods and would, in all probability, prove environmentally inacceptable.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

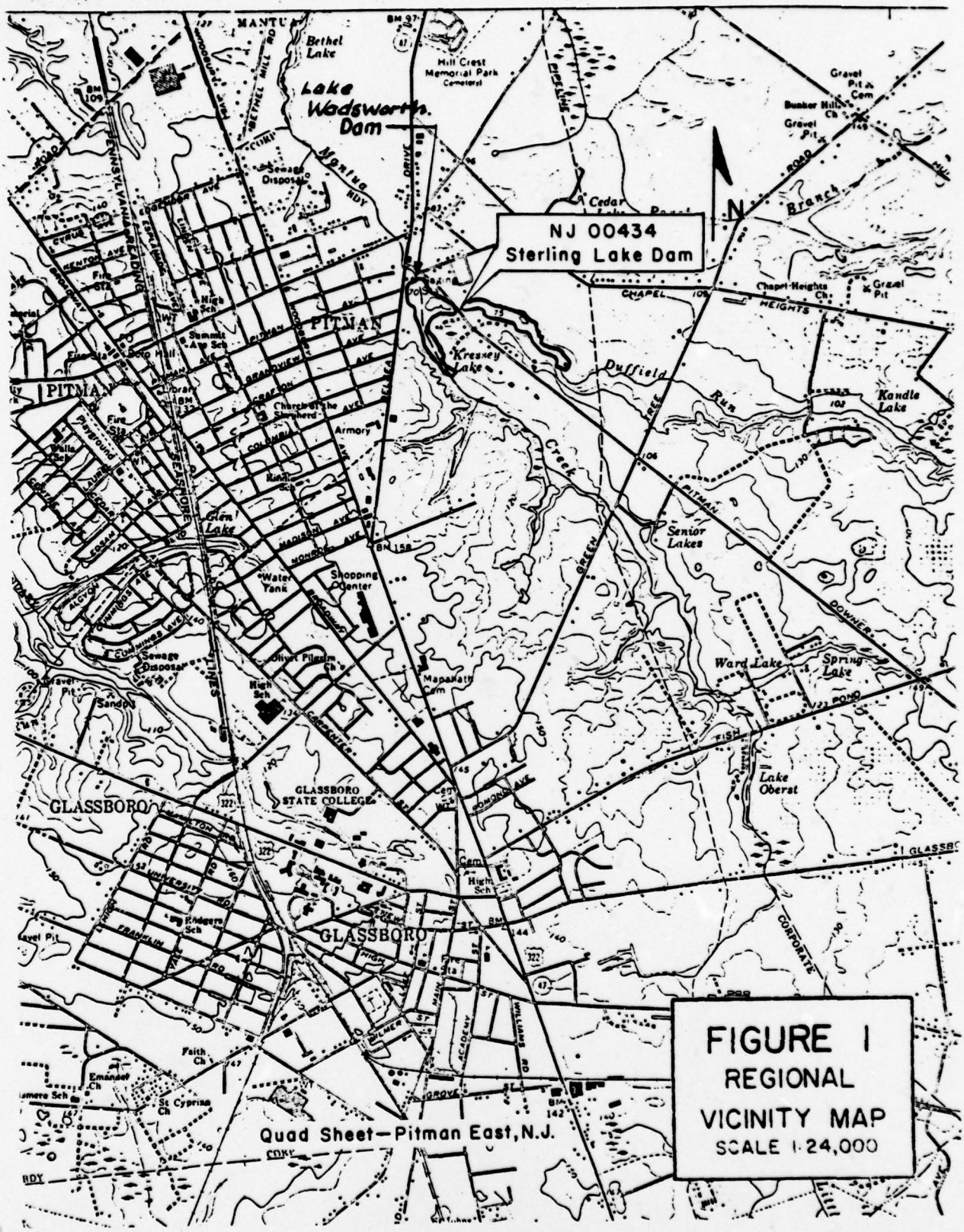
On the basis of visual inspection and present hydrologic criteria contained herein, improvements to the present spillway are not warranted until further, more in-depth studies are completed. The downstream face of the embankment at the extreme low point in the roadway profile could be protected with slope paving and in effect, act as an auxiliary spillway. Additionally, the embankment areas at the ends of all the bridge wingwalls should be regraded and protected with concrete or asphalt slope paving. Other remedial measures to be taken under advisement include:

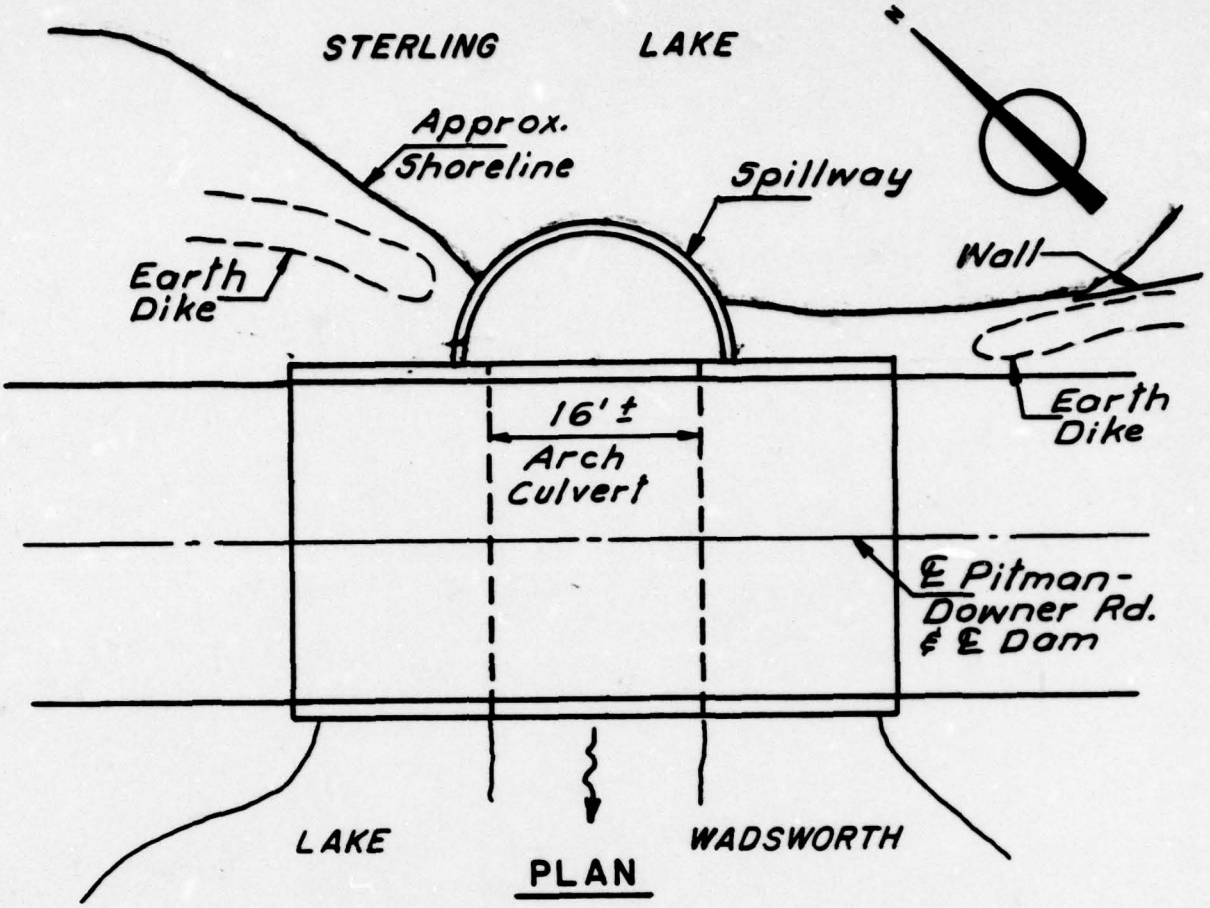
1) Further inspect the submerged portions of the spillway wall and repair the 2' x 2' sluice gate.

2) Construct curbs and catch basins along the roadway gutters to better control the surface run-off.

b. O&M Maintenance and Procedures

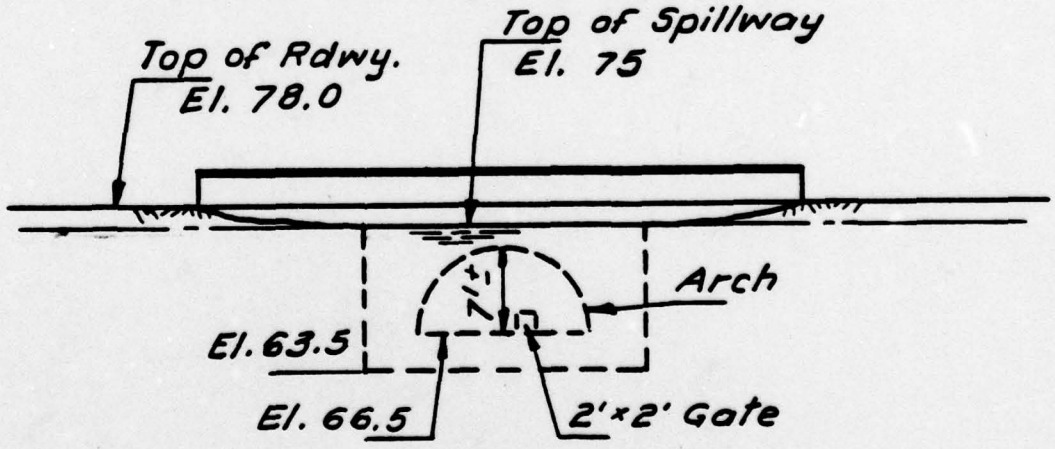
No additional procedures other than those presently in effect appear to be warranted until such time as further studies are completed.


NJ 00434
Sterling Lake Dam
Lake Wadsworth Dam
Bethel Lake
Hill Crest Memorial Park Cemetery
Gravel Pit & Cem
Bunker Hill Ch
Gravel Pit
Cedar Lake
Kresxey Lake
Duffield Run
Kandle Lake
Chapel Heights Ch
Gravel Pit
Senior Lakes
Ward Lake
Spring Lake
Lake Oberst
Glen Lake
Water Tank
Shopping Center
Armory
Church of the Shepherd
Olivet Pilgrim Ch
Masonic Cem
Sewage Disposal
Sand
Gravel Pit
Glassboro State College
Rodgers Sch
Faith Ch
Emanuel Ch
St Cyprian Ch
PITMAN
GLASSBORO
Quad Sheet—Pitman East, N.J.
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000



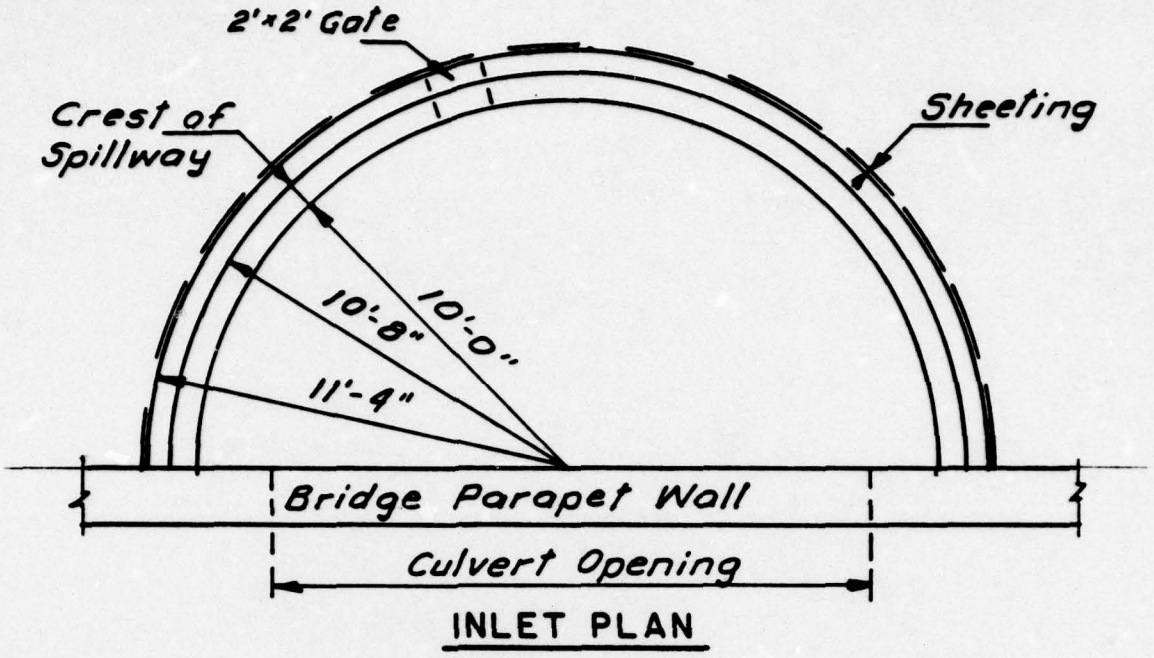
PLAN

Not to Scale

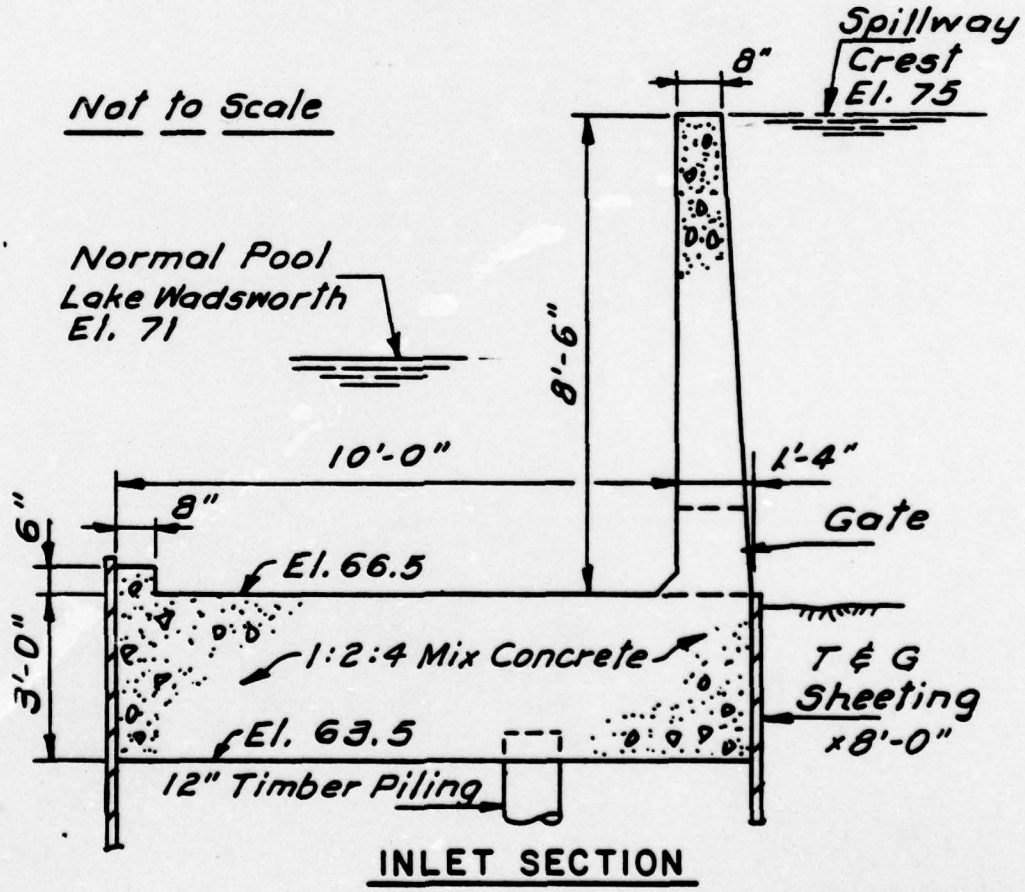


INLET ELEVATION

FIGURE 2



INLET PLAN



INLET SECTION

FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam Sterling Lake County Gloucester State New Jersey Coordinators NJDEP

Date(s) Inspection 13 July 79
9 May 79 Weather Clear Temperature 81°

Pool Elevation at Time of Inspection 75 M.S.L. Tailwater at Time of Inspection 72 M.S.L.

Inspection Personnel:

K. Jolls

L. Baines

K. Greenfield

K. Jolls Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	2-lane asphalt road over entire dam crest.	County Bridge #5-J-14 William C. Cattell, Engr. E.P. Henry, G.C.) Built in 1922.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed. No definable sloped areas.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Low spot in roadway just to right of culvert. Low area approximately 150' long.	Roadway slopes up (2%) on each side. Erosion at each end of wingwalls.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Effective area of dam satisfactory. Width $\tilde{=}$ 50'.	
RIPRAP FAILURES	No riprap	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
Excessive shrub growth, trees, etc.	Heavy secondary growth along road.	No apparent maintenance along road.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory. Ill-defined abutment zone.	Right edge of downstream wingwall catches roadway drainage; requires slope protection.
ANY NOTICEABLE SEEPAGE	Minor seepage at right upstream wingwall in swale.	Appears to come from roadway run-off in cut-off ditch.
STAFF GAGE AND RECORDER	None	
DRAINS	None	Paved roadway ditch on upstream side to left of spillway discharges into spillway.

OUTLET WORKS (COUNTY CULVERT)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Circular box culvert only about 2' clear at intrados.	Effective height of dam ∿ 3' above spillway crest.
INTAKE STRUCTURE	Circular weir. Length = 22' concrete very old but in satisfactory condition	Old brick repaired in notch at centerline. Water appears to be welling up from under spillway at right corner. From volume of flow, spillway could be undermined.
OUTLET STRUCTURE	9'-10' arch culvert	
OUTLET CHANNEL	Main reservoir of lower Lake Kessler (Wadsworth dam.)	a.k.a. Kressey Lake.
EMERGENCY GATE	None observed	Plans indicate 2 x 2 low-level gate. Could not be seen or located.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	See previous page	
APPROACH CHANNEL	Main lake reservoir	
DISCHARGE CHANNEL	None. Headwaters of Kessler Lake.	
BRIDGE AND PIERS	See previous page. County culvert/bridge structure.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Gentle slopes (6:1)	Private ownership of lake.
SEDIMENTATION	None observed	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Clear with few trees (1" to 18") and bushes alongshore.	With Corps of Engineers criteria, the downstream bridge is considered an obstruction.
SLOPES	Slightly eroded	
APPROXIMATE NO. OF HOMES AND POPULATION	One house located on island immediately downstream of dam.	House is above flood elevation.

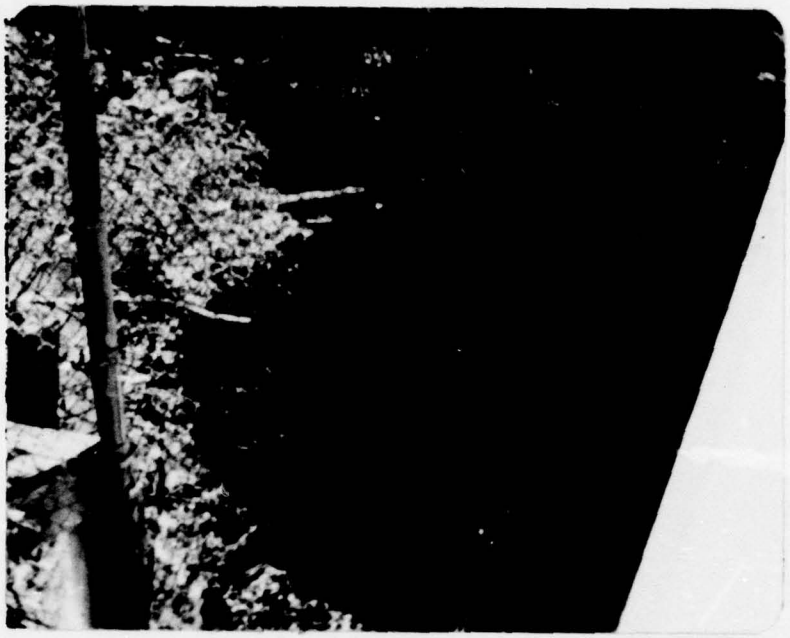
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not available
REGIONAL VICINITY MAP	Available (USGS)
CONSTRUCTION HISTORY	Some available (NJDEP)
TYPICAL SECTIONS OF DAM	Available (NJDEP)
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	Available (NJDEP)
- DETAILS	Available (NJDEP)
-CONSTRAINTS	Not available
-DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Available (NJDEP)

ITEM	REMARKS
SPILLWAY PLAN	Available (NJDEP)
SECTIONS	Available (NJDEP)
DETAILS	Available (NJDEP)
OPERATING EQUIPMENT PLANS & DETAILS	None

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS	Not Available
HYDROLOGY & HYDRAULICS	Not Available
DAM STABILITY	Not Available
SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS	Not Available
BORING RECORDS	Not Available
LABORATORY	Not Available
FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	None Available
BORROW SOURCES	Unknown

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Some details of 1940 modifications available (NJDEP)
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None Available
PRIOR ACCIDENTS OR FAILURE OF DAM	Failure, September 1, 1940
DESCRIPTION	None Available
REPORTS	None Available
MAINTENANCE OPERATION RECORDS	None Available

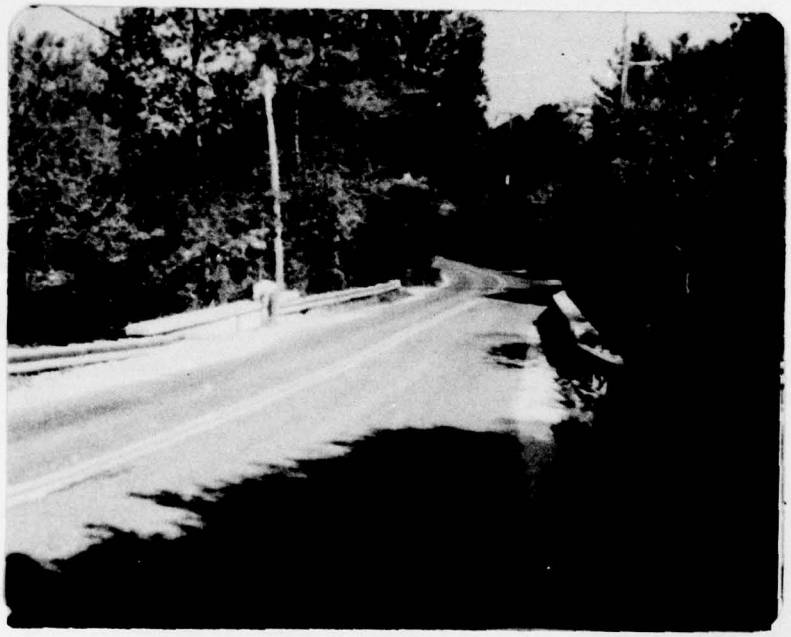


MAY, 1979

VIEW OF CONCRETE SEMICIRCULAR SPILLWAY

APRIL, 1979

View of Outlet Structure May, 1979



View of Crest Looking North May, 1979

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.1 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 75 M.S.L. (60 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 78 M.S.L. (98 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 78 M.S.L.

CREST:

a. Elevation 78 M.S.L.
b. Type Earth embankment with concrete arch spillway
c. Width 50± feet
d. Length 150± feet
e. Location Spillover None
f. Number and Type of Gates None

OUTLET WORKS:

a. Type Semicircular weir
b. Location center of dam
c. Entrance inverts 75 M.S.L.
d. Exit inverts 66.5± M.S.L.
e. Emergency draindown facilities 2' x 2' low level sluiceway

HYDROMETEOROLOGICAL GAGES: Hydro unit #02040202
a. Type Water Quality
b. Location on crest of Wadsworth Lake Dam 1,000' downstream
c. Records 1940-1976

MAXIMUM NON-DAMAGING DISCHARGE: 343 cfs

BY D. J. M. DATE 6-79 | **LOUIS BERGER & ASSOCIATES INC.** | SHEET NO. A1 OF
CHKD. BY DATE | STERLING LAKE DAM | PROJECT C234
SUBJECT

Time of concentration :

length along watercourse to drainage divide = 2.9 miles
= 15,312'

(Overland flow negligible)

$\Delta H = 150 - 75 = 75'$

$\text{Slope} = \frac{75 \times 100}{15,312} = 1/2\ \%$ assume water velocity = 2 ft. s^{-1}

$t_c = \frac{15312}{2 \times 3600} = 2.13$ hours

By California Culverts Method :

$t_c = \left(\frac{11.9 \times 2.9^3}{75}\right)^{0.385} = 1.7$ hours

By kirpichs' formula :

$t_c = \frac{0.00013 \times 15312^{0.77}}{0.0049^{0.385}} = 1.7$ hours

Use average $t_c = 1.9$ hours

$T_p = \frac{0.25}{2} + 0.6 \times 1.9 = 1.27$ hours

LOUIS BERGER & ASSOCIATES INC.

STERLING LAKE DAM

$$Q_p = \frac{484 \times 3.1}{1.27} = 1181 \text{ cfs}$$

Unitgraph :

Time hours	T/T_p	Dimensionless Ordinate (D.O)	Q (cfs) $= Q_p \times DO$
0.25	0.20	0.075	89
0.50	0.39	0.265	313
0.75	0.59	0.580	685
1.00	0.79	0.880	1039
1.25	0.98	0.998	1179
1.50	1.18	0.930	1098
1.75	1.38	0.768	907
2.00	1.57	0.590	697
2.25	1.77	0.435	514
2.50	1.97	0.330	390
2.75	2.17	0.250	295
3.00	2.36	0.191	226
3.25	2.56	0.138	163
3.50	2.76	0.104	123
3.75	2.95	0.080	94
4.00	3.15	0.060	71
4.25	3.35	0.045	53
4.50	3.54	0.034	40
4.75	3.74	0.0267	32
5.00	3.94	0.0200	24

$\Sigma = 8032$ cfs

Check $\frac{8032 \times 12 \times 3600}{3.1 \times 5280^2 \times 4} = 1.0037 \approx 1$ So O.K.

BY D J M DATE 6-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A 3 OF

CHKD. BY _____ DATE _____ STERLING LAKE DAM PROJECT C 234

SUBJECT _____

Precipitation data:

Probable Maximum Precipitation for 200 square miles

- 24 hours (in inches) = 23.8"

Maximum 6 hour percentage = 113 %

Maximum 12 hour percentage = 123 %

Maximum 24 hour percentage = 132 %

(as used in HEC-1 computer program)

BY D.J.M DATE 9-79 | LOUIS BERGER & ASSOCIATES INC. | SHEET NO. ____ OF ____

CKD. BY ____ DATE ____ | Sterling Lake Dam | PROJECT C234

SUBJECT ____

Spillway discharge

flow over weir L = 22'

H	C	Q
1	3.0	66
2	3.0	187
3	3.0	343
4	3.0	528
5	3.0	738
6	3.0	970
7	3.0	1222
8	3.0	1493
9	3.0	1782
10	3.0	2087

flow through Arch A = 130 ft²

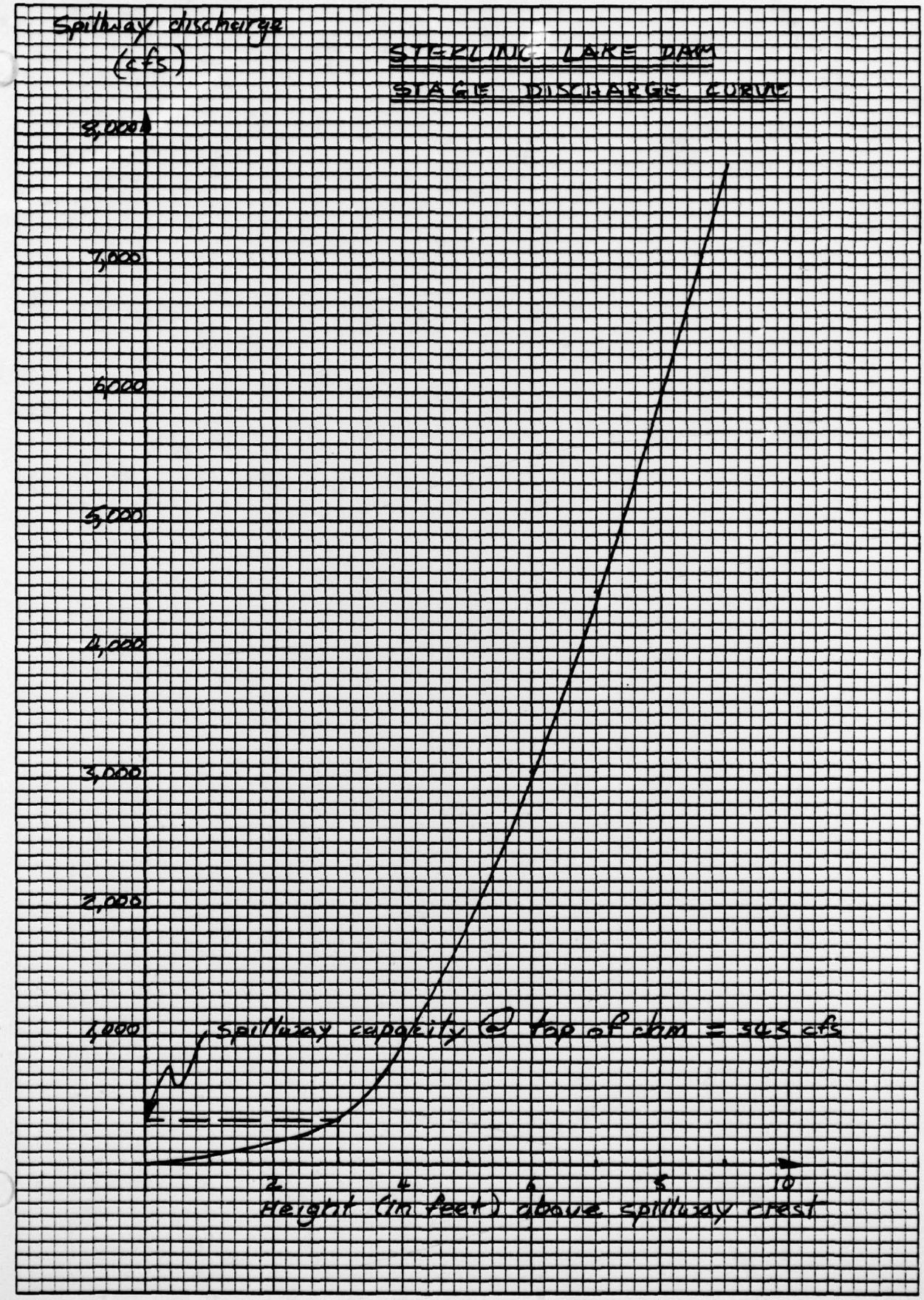
H	C	Q
5	0.5	1166
6		1277
7		1379
8		1474
9		1564
10		1648
11		1729
12		1806
13		1880
14		1951

Over dam L = 150'

H	C	Q
0	2.7	0
1	2.7	405
2	2.7	1146
3	2.7	2104
4	2.7	3240
5	2.7	4528
6	2.7	5952
7	2.7	7501

Σ Q

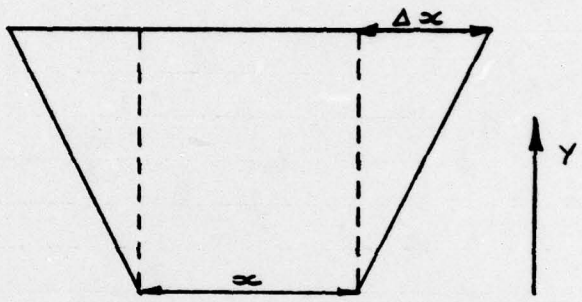
Head in feet above weir	Q (cfs)
0	0
1	66
2	197
3	343
4	933
5	1884
6	3074
7	4462
8	6021
9	7734
10	9452


Spillway discharge (cfs)
STERLING LAKE DAM
STAGE DISCHARGE CURVE
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
spillway capacity @ top of dam = 363 cfs
2
4
6
8
10
Height (in feet) above spillway crest

Surcharge storage :

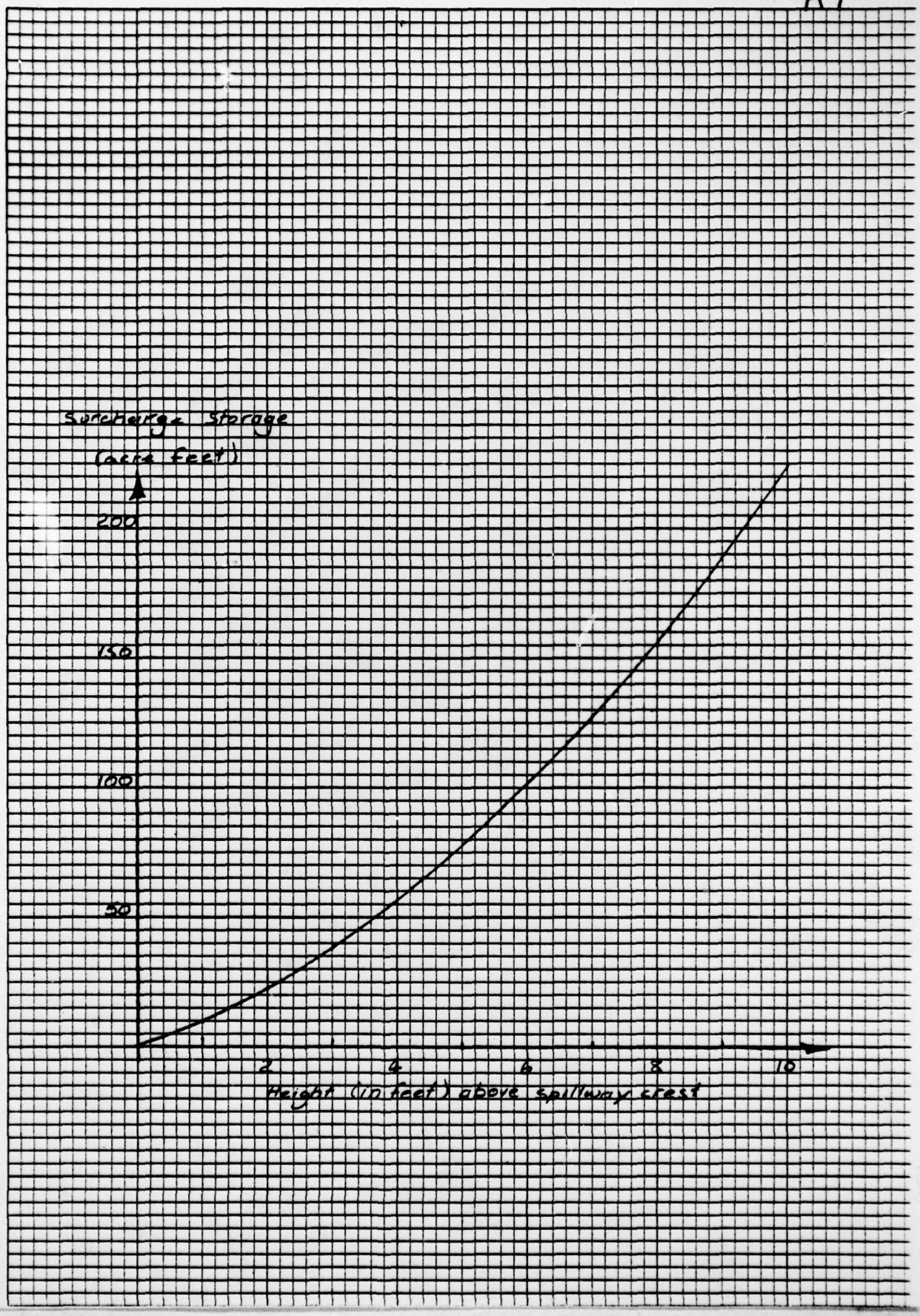
area of lake @ El. 75 = 8.7 acres

area of next contour (El. 80) = 22.4 acres



Increment in volume $\Delta V = (x + \Delta x) y$

Height above Spillway crest	Surcharge storage (acre feet)
0	0
1	10
2	23
3	38
4	57
5	78
6	102
7	128
8	157
9	189
10	224



BY D.J.M. DATE 9-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A8 OF ...
CHKD. BY ..... DATE ..... STERLING LAKE DAM PROJECT C234
SUBJECT Approximate drawdown calculations

At the present time the lake can only be drawn down 4 feet. Through the 2' x 2' opening.

Assume an inflow of 5 cfs

$\therefore$ Average head = 2'

$\therefore$ $Q = 0.5 \times 4 \times \sqrt{64.32 \times 2} - 5 = 18 \text{ cfs}$

Volume $= 8.7 \times 4 \times 43560$

$= 1515888 \text{ ft}^3$

$\therefore$ Time $= \frac{1515888}{18 \times 3600} = 23.4 \text{ hours}$

Say 1 day

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

STERLING LAKE DAM

SHEET NO. A9 OF

PROJECT 6-224

STERLING LAKE DAM INSPECTION & WADSWORTH LAKE DAM INSPECTION
BY D.J.MULLIGAN
JUNE 14 1979

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** *********** ********** ********* **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO STERLING LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	3.10	0.0	3.10	0.80	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.80	113.00	123.00	132.00	0.0	0.0	0.0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUHGG= 20

89.	313.	685.	1039.	1179.	1089.	907.	697.	514.	390.
295.	226.	163.	123.	94.	71.	53.	40.	32.	24.

UNIT GRAPH TOTALS 8023. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.03	0.00	0.
2	0.03	0.00	0.
3	0.03	0.00	0.
4	0.03	0.00	0.
5	0.03	0.00	0.
6	0.03	0.00	0.
7	0.03	0.00	0.
8	0.03	0.00	0.
9	0.03	0.00	0.
10	0.03	0.00	0.
11	0.03	0.00	0.
12	0.03	0.00	0.
13	0.03	0.00	0.

LOUIS BERGER & ASSOCIATES INC.

STERLING LAKE DAM

14	0.03	0.00	0.
15	0.03	0.00	0.
16	0.03	0.00	0.
17	0.03	0.00	0.
18	0.03	0.00	0.
19	0.03	0.00	1.
20	0.03	0.00	3.
21	0.03	0.00	6.
22	0.03	0.00	10.
23	0.03	0.00	14.
24	0.03	0.00	17.
25	0.08	0.05	25.
26	0.08	0.05	43.
27	0.08	0.05	79.
28	0.08	0.05	133.
29	0.08	0.05	194.
30	0.08	0.05	250.
31	0.08	0.05	296.
32	0.08	0.05	332.
33	0.08	0.05	359.
34	0.08	0.05	379.
35	0.08	0.05	394.
36	0.08	0.05	405.
37	0.08	0.05	414.
38	0.08	0.05	420.
39	0.08	0.05	425.
40	0.08	0.05	428.
41	0.08	0.05	431.
42	0.08	0.05	433.
43	0.08	0.05	435.
44	0.08	0.05	436.
45	0.08	0.05	436.
46	0.08	0.05	436.
47	0.08	0.05	436.
48	0.08	0.05	436.
49	0.54	0.51	477.
50	0.54	0.51	620.
51	0.54	0.51	934.
52	0.54	0.51	1411.
53	0.65	0.62	1961.
54	0.65	0.62	2494.
55	0.65	0.62	2984.
56	0.65	0.62	3415.
57	0.81	0.78	3792.
58	0.81	0.78	4138.
59	0.81	0.78	4482.
60	0.81	0.78	4828.
61	2.04	2.02	5258.
62	2.04	2.02	5920.
63	2.04	2.02	6988.
64	2.04	2.02	8443.
65	0.75	0.73	9511.
66	0.75	0.73	10549.
67	0.75	0.73	11259.
68	0.75	0.73	10835.
69	0.59	0.57	9967.
70	0.59	0.57	9017.
71	0.59	0.57	8119.
72	0.59	0.57	7346.
73	0.04	0.02	6653.
74	0.04	0.02	5961.

75	0.04	0.02	5179.
76	0.04	0.02	4297.
77	0.04	0.02	3422.
78	0.04	0.02	2652.
79	0.04	0.02	2025.
80	0.04	0.02	1544.
81	0.04	0.02	1167.
82	0.04	0.02	881.
83	0.04	0.02	663.
84	0.04	0.02	496.
85	0.04	0.02	398.
86	0.04	0.02	324.
87	0.04	0.02	268.
88	0.04	0.02	225.
89	0.04	0.02	196.
90	0.04	0.02	174.
91	0.04	0.02	156.
92	0.04	0.02	143.
93	0.04	0.02	143.
94	0.04	0.02	143.
95	0.04	0.02	143.
96	0.04	0.02	143.
97	0.0	0.0	142.
98	0.0	0.0	136.
99	0.0	0.0	124.
100	0.0	0.0	105.
SUM	25.12	22.60	181557.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	11259.	6492.	1891.	1816.	181554.
INCHES		19.48	22.70	22.70	22.70
AC-FT		3221.	3753.	3753.	3753.

RUNOFF MULTIPLIED BY 0.50

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
3.	5.	7.	9.	12.	21.	40.	67.	97.	125.
148.	166.	179.	189.	197.	203.	207.	210.	212.	214.
216.	217.	217.	218.	218.	218.	218.	218.	238.	310.
467.	705.	980.	1247.	1492.	1707.	1896.	2069.	2241.	2414.
2629.	2960.	3494.	4222.	4956.	5475.	5630.	5418.	4983.	4509.
4060.	3673.	3327.	2980.	2590.	2148.	1711.	1326.	1012.	772.
593.	441.	331.	248.	199.	162.	134.	112.	98.	87.
78.	72.	72.	72.	72.	72.	71.	68.	62.	53.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5630.	3246.	946.	908.	90777.
INCHES		9.74	11.35	11.35	11.35
AC-FT		1610.	1877.	1877.	1877.

********** *********** ********** ********* **********

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
11	1	0	0	0	0	1

ROUTING DATA

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A12.0

PROJECT 6-234

STERLING LAKE DAM

	QLOSS	CLOSS	AVG	IRES	ISAME
	0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	10.	38.	57.	78.	102.	128.	157.	189.	224.
OUTFLOW=	0.	66.	343.	933.	1884.	3074.	4462.	6021.	7734.	9452.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	0.	0.	0.
9	0.	0.	0.
10	0.	0.	0.
11	0.	0.	0.
12	0.	0.	0.
13	0.	0.	0.
14	0.	0.	0.
15	0.	0.	0.
16	0.	0.	0.
17	0.	0.	0.
18	0.	0.	0.
19	0.	0.	0.
20	0.	1.	0.
21	0.	2.	0.
22	0.	4.	1.
23	0.	6.	1.
24	0.	8.	2.
25	1.	10.	3.
26	1.	17.	5.
27	1.	30.	8.
28	2.	53.	14.
29	3.	82.	23.
30	5.	111.	34.
31	7.	137.	47.
32	9.	157.	61.
33	11.	173.	80.
34	13.	184.	99.
35	15.	193.	116.
36	17.	200.	132.
37	18.	205.	145.
38	19.	208.	157.
39	20.	211.	167.
40	21.	213.	176.
41	22.	215.	183.
42	22.	216.	189.
43	23.	217.	194.
44	23.	218.	199.
45	24.	218.	202.
46	24.	218.	205.
47	24.	218.	207.
48	24.	218.	209.
49	25.	228.	213.
50	26.	274.	224.

52	35.	586.	316.
53	44.	843.	529.
54	53.	1114.	813.
55	61.	1369.	1130.
56	68.	1600.	1429.
57	73.	1802.	1667.
58	78.	1983.	1868.
59	82.	2155.	2061.
60	85.	2327.	2242.
61	89.	2522.	2431.
62	94.	2795.	2677.
63	102.	3227.	3050.
64	112.	3858.	3623.
65	125.	4589.	4309.
66	137.	5215.	4956.
67	145.	5552.	5382.
68	147.	5524.	5483.
69	143.	5201.	5281.
70	136.	4746.	4899.
71	128.	4284.	4460.
72	120.	3866.	4038.
73	113.	3500.	3655.
74	106.	3154.	3299.
75	99.	2785.	2940.
76	91.	2369.	2553.
77	83.	1930.	2131.
78	75.	1518.	1726.
79	67.	1169.	1371.
80	60.	892.	1066.
81	54.	678.	846.
82	49.	512.	684.
83	44.	386.	539.
84	40.	290.	418.
85	37.	224.	336.
86	34.	181.	307.
87	31.	148.	277.
88	28.	123.	249.
89	26.	105.	222.
90	23.	92.	198.
91	21.	83.	177.
92	19.	75.	158.
93	18.	72.	142.
94	16.	72.	129.
95	15.	72.	118.
96	14.	72.	110.
97	14.	71.	102.
98	13.	69.	96.
99	12.	65.	90.
100	12.	57.	84.
SUM			90219.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5483.	3230.	940.	902.	902.
INCHES		9.69	11.28	11.28	11.28
AC-FT		1603.	1865.	1865.	1865.

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